For The

IN-1, AUDIO LEVEL INDICATOR

Weinschel Engineering Co., Inc.

Weinschel Engineering

10503 METROPOLITAN AVENUE, KENSINGTON, MD. Lockwood 4-0122

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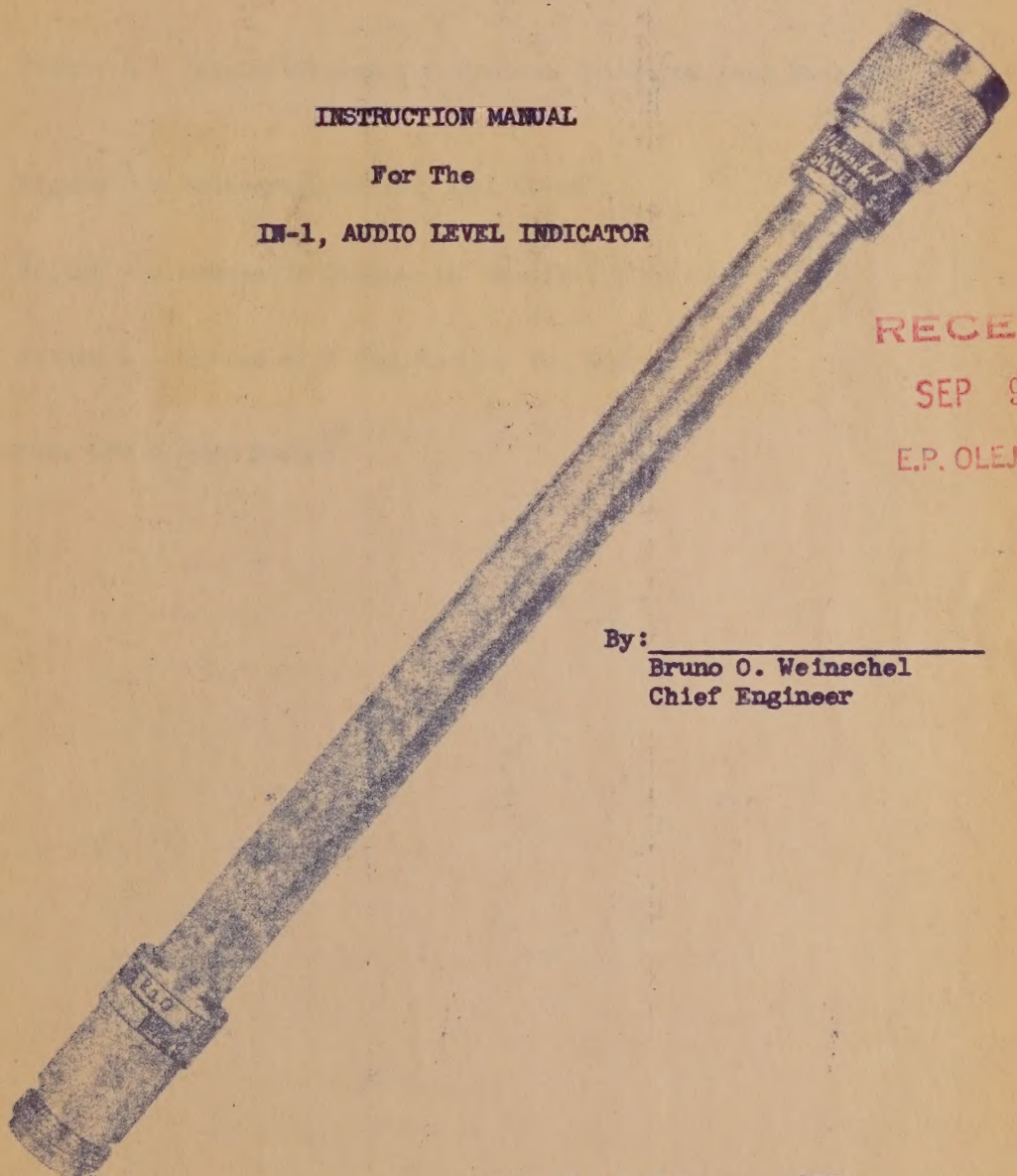

INSTRUCTION MANUAL

For The

IN-1, AUDIO LEVEL INDICATOR

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E.P. OLEJARCZYK

By: _____
Bruno O. Weinschel
Chief Engineer

IM #7

Date: February 1957

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WE CO

ep Attenuators
Coaxial Terminations
Coaxial Attenuator Pads
Coaxial Power & Pulse Power Pads

Power Measuring Bridges
Bolometer Preamplifiers
Thermistor Mounts
Insertion Loss Test Sets

For Standards of Attenuation Use Weinschel Engineering Co.'s Coaxial Pads

LIST OF FIGURES FOR IN-1 INSTRUCTION MANUAL

Figure 1 - "Block Diagram for Typical Insertion Loss Measurement"

Figure 2 - Photograph of the IN-1 (P-60).

Figure 3 - Schematic Diagram of the IN-1 (C114-213)

Figure 4 - Curves of % fluctuation vs. % error.

Form #82 - Test Record

SECTION I

GENERAL INTRODUCTION

1.1 - Scope of Manual

This instruction manual covers the general introduction, theory of operation, operating procedure and maintenance instructions for the Weinschel Engineering Company's Model IN-1 Audio Level Indicator.

1.2 - Purpose of Equipment

The Model IN-1 Audio Level Indicator is designed for use as an indicator when making R-F attenuation measurements using A-F substitution methods. A level indicator for this application should have certain characteristics not found in the usual vacuum tube voltmeter. The time constant of the indicating meter is adjustable to increase the accuracy of observation of small signals in the presence of noise which is desirable since it has been shown that the average indicator position can be relied upon for quite high accuracy even though the noise is sufficient to cause an appreciable amount of jitter in the indicator. This unit makes an ideal companion instrument to the Bolometer Preamplifier, BA-1A, and the Audio Frequency Substitution Attenuator, CF-1, allowing maximum use to be made of these instruments. Figure 1 shows it in such a set-up. It can also be used as a VSWR indicator when used with a square law detector.

1.3 - Specifications

1.3.1 - Sensitivity: For full scale deflection; 100 microvolts input at full gain, 9 volts input at minimum gain. Continuously adjustable over this range by means of three controls: coarse - variable 0-45 db in 5 steps; medium - continuously variable over at least 5 db; fine - continuously variable over 0.2 db. All power ratios referred to R-F levels when using a square law detector. For variation in audio gain multiply all decibel readings by two.

1.3.2 - Frequency: 1000 cps, plus or minus 1%.

1.3.3 - Bandwidth: 120 cps, between 3 db points.

1.3.4 - Equivalent Noise: Less than 5 microvolts referred to the input.

1.3.5 - Input Impedance: 1 megohm.

1.3.6 - Output Indicator: A large mirror scale front panel meter reading the output of a full wave, germanium diode rectifier. The meter reading is proportional to the average signal voltage at the amplifier output. The decibel scale is accurate to plus or minus .05 db (R-F) from 0-5 db. A VSWR scale is also provided.

1.3.7 - Output Indicator Time Constant:

Six time constants available through front panel switch: 0.1, 1, 2, 3, 5 and 10 seconds.

1.3.8 - Power Input: 50 VA at 115 volts, 50-60 cps.

1.3.9 - Connectors: BNC female for input.

1.3.10 - Stability vs. Line Voltage:

Output indication does not vary more than plus or minus 0.1 db for line voltage variation from 105 to 125 volts.

1.3.11 - Dimensions: Panel - 8-3/4" x 19". Max. depth behind panel - 13". Relay rack mounting.

1.4 - Description

1.4.1 - Figure 2 is a photograph of the IN-1 showing the arrangement of the front panel controls and the meter. The mirror scale output indicator is located on the upper left part of the panel and the "meter time constant" switch at the upper right. Across the bottom of the panel from left to right are the "Input" connector, the "coarse" and "fine" gain controls, the pilot light to indicate when primary power is on, the "on-off" switch and the "pre-charge adjustment", a screwdriver control. The function of these various controls is described in Sections II and III of the manual.

1.4.2 - The IN-1 consists of a variable gain amplifier broadly tuned to 1000 cps. The amplifier output is rectified and the resultant DC is indicated on a front panel meter. The input is applied across a voltage divider which acts as a coarse gain control. The fine gain adjustment is an interstage, continuously variable voltage divider. A front panel switch allows adjustment of the output meter time constant. The use of a long time constant reduces the effect of noise in producing random fluctuations in output indications, but at the same time has the disadvantage that it requires a long time for the meter to reach equilibrium after the application of a voltage. To reduce this time, the capacitors that are switched on to increase the time constant are pre-charged to a voltage near the final voltage to which they will be charged by the metering circuit. This voltage is obtained from a full wave bridge rectifier across the filament winding. A screwdriver adjustment, accessible from the front panel, sets the voltage to which these capacitors are pre-charged. A regulated power supply is self-contained.

1.5 - Other Uses For The Model IN-1

1.5.1 - Although the Model IN-1 was designed for use in a set-up similar to that shown in Figure 1, it is useful wherever a sensitive, low noise, 1000 cps indicator is required.

1.5.2 - It is useful as a voltage standing wave indicator in circuits operating at very low levels and employing square law detectors in going from R-F to 1000 cps.

1.6 - Unpacking and Preparation For Use

The instrument is packed in a standard double container with 3" of packing material between the inner and outer case. The only extra items are this Instruction Manual and the line cord. Normal care should be exercised when removing the instrument from the case and removing the packing material. Examine the packing to be sure that there are no loose items before discarding it.

Vacuum tubes are shipped in position and are locked in place with tube clamps. After unpacking examine the instrument for any evidence of damage. If there is any evidence of physical damage to the instrument, notify the shipping company immediately. If there is none proceed with preparations for use.

Make certain that the tubes are properly seated in their sockets and that the fuse is intact. The line cord may now be plugged into a suitable AC outlet. Set the coarse gain control to the "0" db position with the medium and fine controls at about the center of their range. The equipment should now be switched "On". The ruby pilot light should light at once. Allow 60 seconds for the tubes to warm up and stabilize after which the instrument is ready for use.

SECTION II

THEORY OF OPERATION

2.1 - Input Attenuator

Reference to the schematic circuit diagram of the Model IN-1, Figure 3, should be made throughout the reading of this section.

The input attenuator to the IN-1 consists of a voltage divider having a total resistance of one megohm and taps such that the voltage applied to the amplifier input is varied in steps corresponding to 5 db variations in R-F power if the R-F power is rectified in a square law detector. Thus a change in attenuator setting of 10 db results in a 10:1 change in the voltage input to the amplifier. This must be borne in mind if the instrument is used with other than a square law detector.

2.2 - Amplifier

The voltage from the input attenuator is applied to the grid of V1, a premium pentode, Type 6136, which in turn drives a cathode follower, one-half of V2, a Type 5814 dual triode. The cathode follower furnishes a low impedance source for the medium and fine gain control circuits allowing the use of low resistance potentiometers thus reducing the stray pickup from nearby 60 cps or 1000 cps sources.

The cathode follower is followed by three resistance coupled amplifier stages with all or part of their cathode resistors left unbypassed to furnish negative feedback thus stabilizing them against variations in operating parameters.

The last of these resistance coupled amplifiers drives the final triode amplifier. This stage has a parallel resonant circuit consisting of L1 and C11, in its input, broadly tuning it to 1000 cps. This stage drives the full-wave rectifier and metering circuit.

2.3 - Output Indicator

2.3.1 - Two Type 1N34 germanium diodes operate as a full-wave rectifier to drive the output indicating meter. The meter is shunted by R-37 and R-38 in series, and a capacitor selected by the front panel "Meter Time Constant" switch. The function of this control is to adjust the time constant of the indicating circuit to the optimum value considering the amount of noise present. The time constant should be long enough to effectively damp out the random fluctuations due to noise but no longer than necessary since it increases the time required for the meter to reach equilibrium after a change in amplifier output.

2.3.2 - As previously mentioned, increasing the meter time constant has the effect of increasing the time required for the meter to reach equilibrium. To help alleviate this condition the Model IN-1 has a pre-charging circuit built in that allows pre-charging of the meter shunting capacitors before they are placed in shunt with the meter. This is particularly helpful when the Model IN-1 is used in a setup similar to that shown in Figure 1 where the IN-1 indication is always returned to the same point by the addition or removal of attenuation in the audio channel to compensate for variation in R-F power level at the detector. Under these conditions the voltage to which the capacitors should be pre-charged is known quite closely.

2.3.3 - Damping the meter fluctuations merely causes the indicator to rest on its average position. If the amount of noise present is quite small this average can be taken as the indication due to signal only, with a very small resultant error. As the amount of noise increases, the indicator tends to read high and the magnitude of this error can be found by reference to the curves given in Figure 4. A family of curves are given indicating the db increase in average indicator readings vs. fluctuations in db in the indicator for various indicator time constants.

To use these curves switch to the shortest time constant that will give an easily estimated fluctuation in decibels. Entering the curve with this figure, read the error in decibels off the appropriate curve for the meter time constant in use. As an example, assume that a fluctuation of 0.3 db in the indicator is noted with the time constant switch in the "shortest" position (τ= 0.1 sec.). The indication can be expected to be .06 db high when a long time constant is switched in and the indicator allowed to come to rest. If a fluctuation of 0.1 db were noted with the time constant switch in the second position (τ = 1.0 sec.), an error of .08 db could be expected.

The dashed curves are drawn assuming no bandwidth limiting ahead of the IN-1. If there is bandwidth limiting to 35 cps ahead of the IN-1 the solid curves of Figure 4 should be used. This corresponds to use of the BA-1A amplifier ahead of the IN-1. It should be noted that a given fluctuation indicates a larger error when there is no bandwidth limiting ahead of the IN-1.

SECTION III

OPERATING PROCEDURE.

3.1 - R-F Attenuation Measurements

Use of the IN-1 in this application is indicated in Figure 1. With the pad under test in the setup as shown, and the Audio Frequency Substitution Attenuator set to zero, the Audio Level Indicator, IN-1, is adjusted to show close to full scale reading, say 0.5 db below full scale. The pad under test is then removed and the Audio Frequency Substitution Attenuator adjusted to return the IN-1 to its previous indication. The amount of attenuation added in the Audio Frequency channel is then a measure of the attenuation of the pad under test. Since a square law detector is used it is necessary to substitute twice as much attenuation (in db) in the audio channel as removed in the R-F channel. The Model CF-1 is calibrated to indicate directly in R-F attenuation.

With the pad under test in the setup, the signal at the Bolometer Preamplifier input may be quite low and the signal to noise ratio such that an appreciable fluctuation of IN-1 meter is evident. It is under these conditions that the variable meter time constant feature can be used to advantage. The time constant is increased until the meter indication is steady and easily read. If a long time constant is required the pre-charge adjustment should be employed. Let us assume that the meter is to be used at 0.5 db from full scale. A signal is applied to the IN-1 to produce this indication with the time constant switch in the "shortest" position. The precharge adjustment is varied until the meter reading does not change when the time constant is increased.

With a noisy signal present it is adjusted to the best estimated position using a short time constant and then the time constant increased and final adjustments made. The possible error in the reading can be estimated as described in paragraph 2.3.3. This error must be added as a correction to the attenuation indicated on the substitution attenuator.

3.2 - In Other Applications

The IN-1 can be used as a reference voltmeter in any 1000 cps circuit as described in the previous paragraph. In addition, it will directly indicate variations in the input voltage up to 5 db with an accuracy of plus or minus .05 db. It is thus useful as a vernier when making substitution measurements or where only small changes are to be indicated. This includes its use as a VSWR indicator.

The remarks made in paragraph 3.1 with regard to the time constant and precharge adjustment controls also apply to the IN-1 when it is used in these other applications.

SECTION IV

MAINTENANCE.

4.1 - Introduction

The Model IN-1 Audio Level Indicator has been designed to require a minimum of maintenance. However, should trouble develop and service become necessary, the usual procedure for maintenance of vacuum tube amplifiers applies.

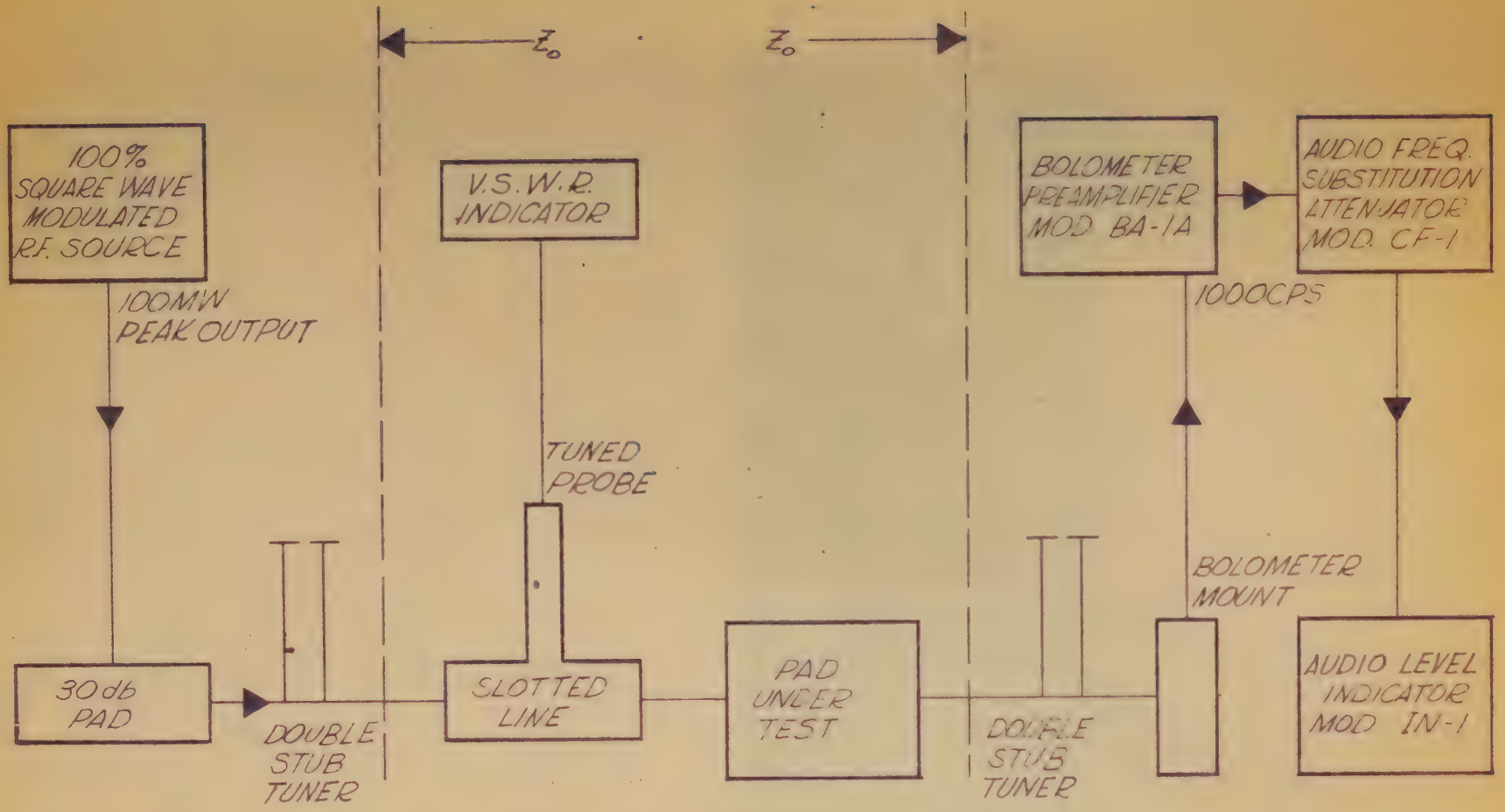
4.2 - General Maintenance

4.2.1 - Tubes:

The checks usually made to determine the condition of vacuum tubes will normally suffice.

4.2.2 - Components

Resistance, capacity and voltage values are shown in Figure 3, (Dwg. C114-213). Voltage measurements were made using a 20,000 ohms per voltmeter. The resistors in the input attenuator are held to close tolerances and should not be replaced by ordinary composition resistors since the attenuation steps will no longer be accurate and the noise level may be increased.



BLOCK DIAGRAM FOR TYPICAL INSERTION LOSS MEASUREMENT

FIGURE 1

P - 60
Audio Level Indicator For
R.F. Square Law Detector
Model IN-1

WEINSCHEL ENGINEERING
Kensington, Maryland

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E.P. OLEJARCZ K

TEST RECORD

INDICATOR

Customer _____ Model Number IN-1

Date July 1, 1958 Serial Number 29

Job Number _____

1. Sensitivity:

For full scale deflection.

Max. gain (full CW) 135 μV input

Min. gain (full CCW) 15.5 V input

2. Frequency Stability:

Peak frequency after 1/2 hour 999.3 cps

After 1 hour 999.3 cps

with 125 V rms line voltage 999.3 cps

with 130 V rms line voltage 999.3 cps

3. Band Width:

High frequency 3 db point 1054.7 cps

Low frequency 3 db point 945.4 cps

4. Output Stability:

Input voltage = 100 μV

Output meter reading with 105 VAC

Line input: -.2 db

with 130 VAC: 0 db

Form #62

Serial Number 29

5. Attenuator Test:

Coarse gain setting	Deviation
5 db	+ .01 db
10 db	0 db
15 db	+ .01 db
20 db	- .01 db
25 db	- .02 db
30 db	- .02 db
35 db	- .03 db
40 db	- .03 db
45 db	+ .04 db

6. Precharging Circuit:

Meter time constant setting	Stop watch reading
.1 Sec.	.1 Sec.
1 Sec.	.8 Sec.
2 Sec.	1.4 Sec.
3 Sec.	2.9 Sec.
5 Sec.	5.9 Sec.
10 Sec.	9.8 Sec.

7. Noise Test:

With shielded 200Ω ohms resistor in input and coarse gain setting at 40 db.

Noise voltage at C9: .3 Vrms

Calculated Noise at input 1.4μVrms

With input open

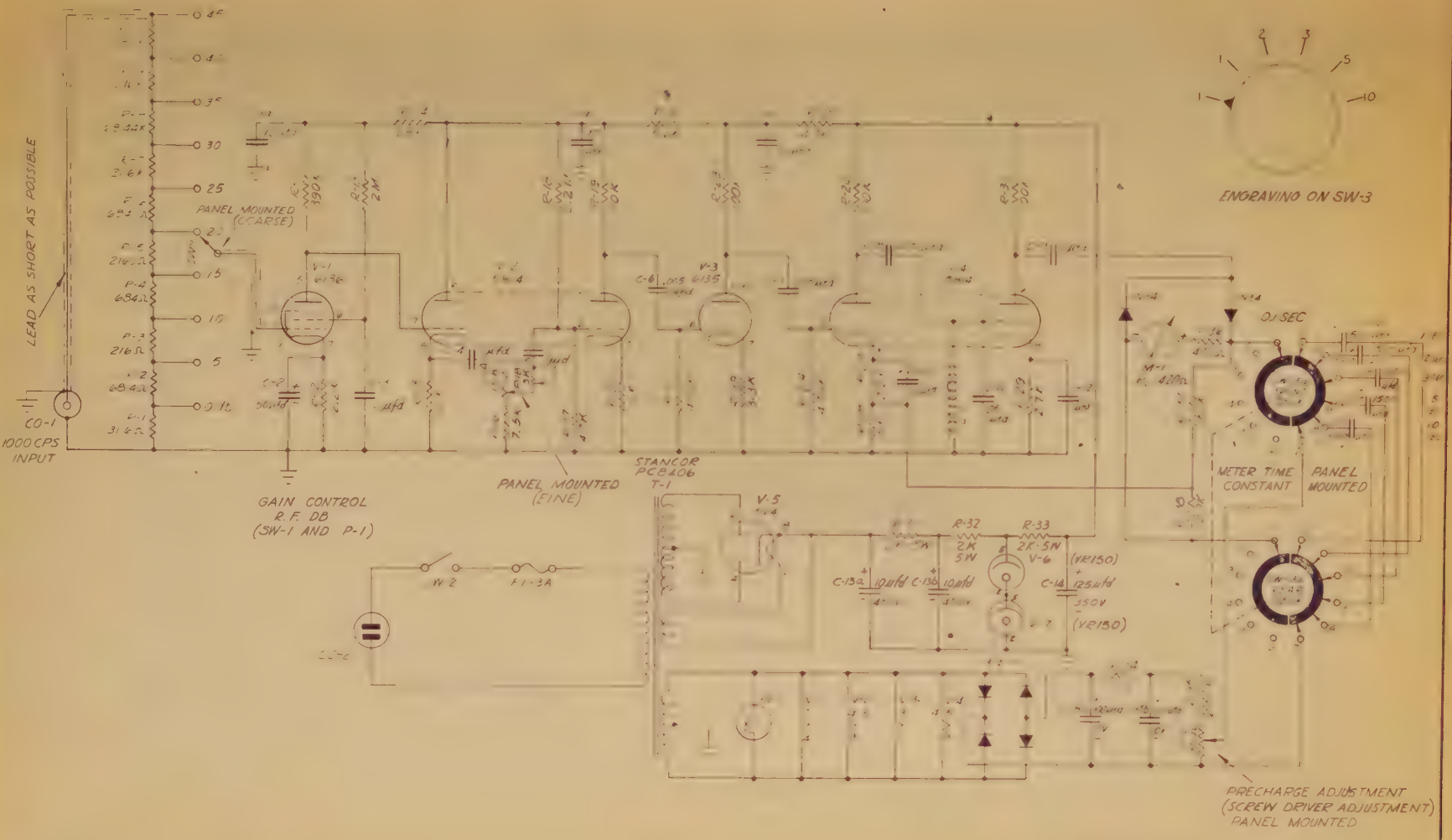
Noise voltage at C9: 1.06 Vrms

Calculated noise at input 5 μVrms

Tested by C Lark

Engineer H Olson

Form No. 62



NOTE:
FOR PARTS LIST OF ELECTRICAL COMPONENTS, SEE DWG. A114-223.

REVISIONS		
A	REVISED	7-17-56
B	REVISED	2-3-57

USED ON	ASSY DWG
A-7	

Weinschel Engineering Co.
SILVER SPRING, MD.

SCHEMATIC -IN-1
AUDIO LEVEL INDICATOR

MATERIAL
FINISH
SCALE —
C 114-213 B

B C114-213

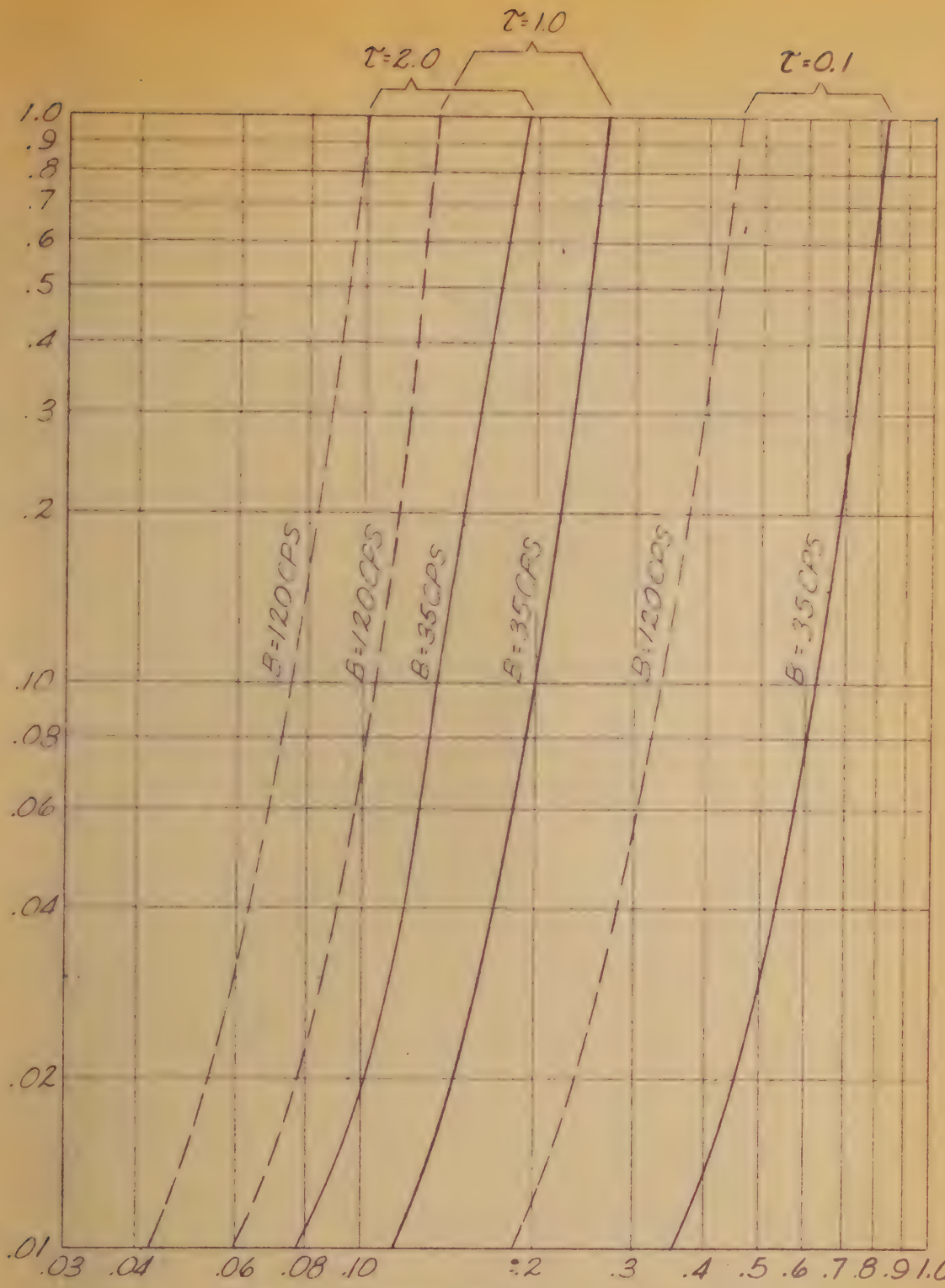


FIGURE 4

DM #7

2-19-57 R.L.D.

WEINSCHEL ENGINEERING
Kensington, Maryland

TEST RECORD

INDICATOR

Customer _____ Model Number IN-1

Date July 1, 1958 Serial Number 29

Job Number _____

A. Sensitivity:

For full scale deflection

Max. gain (full CW)	135	µV Input
Min. gain (full CCW)	15.5	V Input

B. Frequency Stability:

Test frequency after 1/2 hour	999.3	cps
After 1 hour	999.3	cps
with [illegible] rms line voltage	999.3	cps
with 130 V rms line voltage	999.3	cps

C. Audio Width:

High frequency 3 db point	1054.7	cps
Low frequency 3 db point	945.4	cps

D. Output Stability:

Input voltage = 100 uV

Output meter reading with 105 VAC

Line input:	-.2	db
with 130 VAC:	0	db

Form No.

Serial Number: 29

5. Attenuator Test:

Coarse gain setting	Deviation
5 db	+ .01 db
10 db	0 db
15 db	+ .01 db
20 db	- .01 db
25 db	- .02 db
30 db	- .02 db
35 db	- .03 db
40 db	- .03 db
45 db	+ .04 db

6. Precharging Circuit:

Meter time constant setting	Stop watch reading
.1 Sec.	.1 Sec.
1 Sec.	.8 Sec.
2 Sec.	1.4 Sec.
3 Sec.	2.9 Sec.
5 Sec.	5.9 Sec.
10 Sec.	9.8 Sec.

7. Noise Test:

With shielded 2000 ohms resistor in input and coarse gain setting at 40 db.

Noise voltage at C9: .3 Vrms

Calculated Noise at input 1.4μVrms

With input open

Noise voltage at C9: 1.06 Vrms

Calculated noise at input 5 μVrms

Tested by C Lark

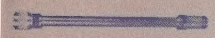
Engineer [illegible]

Form No. 42

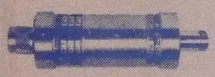
SYSTEM ENGINEERS: We can supply large quantities of coaxial attenuators to your specifications on short notice.

Manufacturers of coaxial attenuators to MIL specs. All units undergo thorough testing before leaving the factory.

Model 50



Model 210

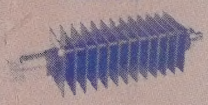


Model 10

Model 502

Model 503

Model 310



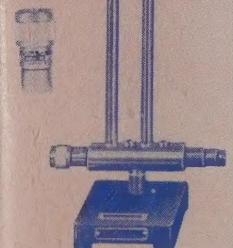
Model 540

Model 528

Model 519

Model 525

Model 64



Model 535

Model DS-109

Mod. 50 Typical Spec: Att. — 10 db ± .05 db at DC, ± 0.2 db to 1 KMC; VSWR < 1.15 to 1 KMC; Max. power input — 1 watt ave., 1 kw peak (pulse width < 5μ sec.); Calibration at DC, 400 mcs and 1000 mcs; Calibration Accuracy: DC — ±.01 db, 400 and 1000 mcs — 0.1 db; Zo = 50 ohms; Connectors—Type N. Other models from 1 to 50 db.

Mod. 210 Typical Spec: Att. — 3 db ± 0.1 db at 4 KMC, — 0.3 db at 1 KMC and + 0.2 db at 10 KMC; VSWR < 1.3 to 10 KMC; Freq. range — 0.6 to 10 KMC; Max. power input — 5 watts ave., 10 kw peak (pulse width < 5μ sec.); Calibration at 1, 4 and 10 KMC; Calibration Accuracy ± 0.1 db; Zo = 50 ohms; Connectors—Type N. Other models from 1 to 20 db.

Mod. 10 Typical Spec: Att. — 3 db ± 0.2 db from DC to 1000 mcs; VSWR < 1.15 to 1000 mcs; Max. power input — 10 watts ave.; Power Sensitivity — .01 db/10 watts; Calibration at DC, 400 mcs, 750 mcs and 1000 mcs; Calibration accuracy: DC — ±.02 db, R.F. — ±.05 db; Zo = 50 ohms; Connectors—Type N. Other 10 watt attenuators from 1 db to 10 db.

Mod 310: —50 ohm, S-band pads, 5-20 db.

Mod. 502-503: —50 ohm, 1-10 KMC, 3-30 db.

Mod. 519: —46.5 ohm, 7/8" coaxial, 1-4 KMC, 3-10 db, 10 watts ave, 20 kw peak.

Mod. 525: —46.5 ohm, 7/8" coaxial, DC-1 KMC, 3-20 db.

Model 528: A 30 watt, 34.9 db precision attenuator, DC-600 mcs.

Mod. 530: Similar to Mod. 210 with additional shock resistance.

Mod. 540: Similar to Mod. 210 with BNC connectors.

Mod. 64: A step attenuator for use from DC to 1 KMC. Attenuation variable from 0-64 db in 0.1 db steps; Zo = 50 ohms; VSWR < 1.15; Freq. sensitivity of insertion loss DC to 1 KMC: 1-10 db — 0.1 db, 20-50 db — 0.1/10 db.

Mod. 535 Coax. Terminations: 50 ohm terminations available with all standard connectors, e.g., with type N connectors — VSWR < 1.05 to 4 KMC.

We also manufacture a line of double-stub tuners covering the range from 200 mcs to 10 KMC.

BA-1A AMPLIFIER: A low noise, high gain bolometer preamplifier selective to 1000 cps. Linear to 0.2 db over 60 db range. Particularly useful in r-f power ratio measurements with the CF-1 and IN-1.

CF-1 ATTENUATOR: An audio attenuator used in measuring r-f attenuation to ± .02 db using substitution methods. Calibrated to read r-f attenuation directly when used with a square law detector. A companion instrument to the BA-1A and IN-1.

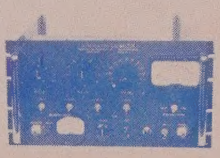
IN-1 INDICATOR: Allows substitution measurements down to levels where other indicators are badly bothered by noise. An ideal companion instrument to the BA-1A and CF-1.

MO-1A SQUARE WAVE MODULATOR: A very stable source of 1000 cps square waves for klystron modulation; particularly where narrow band circuitry is used to reduce noise in low level r-f measurements.

ND-1 DIFFERENTIAL NULL DETECTOR: An extremely sensitive, accurate and convenient detector for use in substitution type measurements where it is required to return a signal to a precise level.

MS-1, 2 & 3 R.F. SOURCES: Three R-F sources covering the range from 50 to 2000 mcs. All include 1000 cps square wave modulators and automatic regulator circuits to maintain constant output. A well regulated output of 200 mw peak is available to 920 mcs and 100 mw peak to 2000 mcs. The outstanding feature of these units is the constancy of output under variations in loading, power line variation, etc.

BA-5 ATTENUATION CALIBRATOR: Contains a bolometer preamplifier, audio substitution attenuator and indicator in one unit. Useful where a large number of attenuation measurements are to be made.



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Kensington, Maryland

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